

Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

VII.

THE DIMENSIONS AND PROPORTIONS OF THE TEMPLE OF ZEUS AT OLYMPIA.

By Charles Eliot Norton,

Professor of the History of Art in Harvard College.

Presented Oct. 10, 1877.

The information given by ancient writers concerning the erection and plan of this famous Temple would seem curiously scanty, but for the fact that there is not one of the most noted buildings of the Greeks, concerning the architecture of which a detailed account has reached us from antiquity. In this instance (as in so many others of the same kind) Pausanias is the chief authority. He tells us that Libon, of Elis, was the architect of the Temple; that it was built from the spoils which the Eleians won from the conquest of Pisa and her neighbors.* This conquest took place in the year 572 B.C.; and it has been inferred, from the words of Pausanias, that the Temple was begun not long after this time. But, if this were the fact, the progress of the work must have been exceedingly slow; for it did not receive the image of the God within its shrine until after the completion of the Parthenon, when Phidias went to Elis for the purpose of making the colossal statue of Zeus; and the figures of the groups in the pediments were not set in their places till about the same time, that is, not far from 435 B.C.†

Pausanias, however, does not say any thing of the date of the erection of the Temple; and no inference can be drawn from the mention of Libon as its architect, for nothing is known of him beyond this statement.‡

The evidence of its date which the plan of the Temple itself affords would lead to the conclusion that it could hardly have been begun

* Pausanias, v. x. 3.

† Müller, "De Phidiæ Vita et Operibus," § 12.

‡ Brunn, "Geschichte der Griechischen Kunstler," ii. 369: "Wir vermögen also nur zu sagen dass er [der Tempel] in der 86. Olympiade vollendet war."

before the first quarter of the fifth century B.C.; probably between 480 and 460 B.C.*

In many points of architectural style, it bears a resemblance to the Temple of Athene (sometimes known as that of Zeus Panhellenius) on the island of Ægina, which was erected in this part of the century; and it stands, perhaps, in still closer architectural relations with the Theseium, at Athens, — a building of which the precise date is not known, but which was probably erected between 470 and 460 B.C.

The Temple of Zeus at Olympia, on account of its national relations, was by far the most important and famous temple of the Peloponnesus. Few temples in the ancient world excelled it in renown, in dignity of association, or in general reverence; few surpassed it in the number and splendor of their dedicatory offerings; few were of larger dimensions, or of more beautiful proportions, or more nobly adorned: —

Οὐκ ἐν ταῖς ζαθέαις Ἀθάναις
Εὐκίονες ἦσαν αὐλαὶ
Θεῶν μόνον.

No other temple, not even that of Delphi, was to an equal degree the temple of the whole Greek race.

Long after Greece had fallen from her station as the living leader of the world in science and in art, long after she had become a Roman dependency, the Olympic Games were still celebrated in sight of this splendid and stately Temple. There is no knowledge of the precise date of its destruction. It was burned probably about the time of the stern edict of the Emperor Theodosius II. against the heathens and their sanctuaries, in the year 426.†

From the time of its destruction, the ruins lay exposed to the injury of flood and storm and earthquake, and to the more wanton injuries of man. By degrees, the soil accumulated over them, and vegetation covered the shapeless heap. The place became solitary and unhealthy;

* Urlichs, in the "Verhandl. der 25. Versammlung Deutscher Philologen," in Halle, 1867, p. 75, fixes the date of the building between Ol. 77, 3–4, and 80, 3–4; that is, from 470 to 457 B.C. And this view is adopted by Krell, "Geschichte des Dorischen Styls," 1870, p. 85.

† The only notice of its destruction is found in a mutilated note by a scholiast tó Lucian's Rhet. Precept, printed in the edition of Jacobitz, Leipsic, 1861, T. iv. p. 221: *διήρκεσεν μέχρι τοῦ μικροῦ . . . ὃς Ἀρκαδίου υἱὸς ἦν. τ. . . ναοῦ τοῦ Ὀλυμπίου Διὸς ἐμπρη. . .* And so the temple crumbles, and falls to long neglect. Cf. Herkberg, "Der Untergang des Hellanismus," Halle, 1875, p. 428.

and for many centuries no traveller was allured by its ancient fame to visit the scene which had once been the gathering-place of the civilized world. There is an utter blank in its history. But the revived interest in the antiquities and art of Greece, of which the publication of Stuart and Revett's monumental work on the Antiquities of Athens was at once a sign and a stimulus, led travellers, in the early part of this century, to turn their steps to Olympia, in order to investigate the remains which might still be found there.* It was not, however, till 1829 that any thorough exploration of the ruins was undertaken. In that year, they were carefully investigated and measured by an expedition, of which M. Abel Blouet was the head, sent out by the French government; and the results were published, in 1831, in the well-known work, the "Expédition scientifique de Morée." According to Pausanias, the Temple was 230 feet in length, 98 feet in breadth, and 68 feet in height; and it was not without surprise that it was found that the French measures of the length and breadth of the Temple differed widely from the measures given by the only ancient authority.

For more than forty years, no further investigations were undertaken on the spot. But the German expedition which began its work of excavation at Olympia in 1875, and which has already made discoveries of the highest interest and importance, has once more taken the measures of the ruins, and with results generally corresponding with those of the French expedition.†

It thus appears evident that the measures given by Pausanias are incorrect; and this conclusion is confirmed by the fact, that no simple ratio, such as appears to have been frequently, if not always, established in the main dimensions of the Greek temples, exists between the dimensions as stated by him.

It is likely, indeed, that at the time when Pausanias wrote (near the close of the second century of our era), the knowledge of the mathematical principles on which the science of Greek architecture rested, was, if not wholly lost, at least completely neglected. No ancient treatise on the subject has come down to us. Vitruvius gives very little information regarding it; and it has been reserved for students in this century to rediscover some of the elements of this lost science,

* Mr. J. S. Stanhope, in 1824, in his work entitled, "Olympia; or Topography illustrative of the Plain of Olympia, and of the Ruins of the City of Elis," gave a series of views of the general features of the locality, and of the condition of the ruins.

† These measures are given by Herr F. Adler in "Die Ausgrabungen zu Olympia," by Curtius, Adler, and Hirschfeld, Berlin, 1876, p. 20.

and to open the way, it may be hoped, to its gradual complete reconstruction.

It would seem that the architect of a Doric temple began his work by laying out what may be called an ideal scheme, based upon exact numerical relations of the various parts. Having to build a temple of a certain magnitude, he determined the number of columns it should have on the fronts and sides; and fixed the proportions that should exist between the height, the breadth, and the length of his building. These were all to be regulated according to the size of the columns. The height of the column was determined by its diameter at the foot of the shaft; and, as the shaft diminished from base to summit, the upper diameter was accurately proportioned to the lower in a simple ratio. To secure the exactness of these proportions, the diameter of the base was divided into sixty minutes, and these minutes served as a common measure of all the members of the building.

Not merely in the columns, but also in the proportions of the other parts and divisions of their structures, "the Greek architects attached great value to simple ratios of low natural numbers." *

It appears, further, that the ratios employed in any particular building were comparatively few.†

The first point, then, in the investigation of the system of proportions in any given temple, is, after obtaining (if possible) the measure of its breadth and length, to endeavor to ascertain the diameter of the peristyle columns. But here a difficulty exists, unless we have opportunity to measure a number of columns, and so to obtain an average which may afford the probable ideal diameter. For, after having laid out his plan on an exact mathematical scheme, the architect in its execution varied the dimensions of similar parts, — slightly it is true, but still sufficiently to make it unsafe to assume that a single example

* See "Memoir on the Systems of Proportions employed in the Design of the Doric Temples at Phigaleia and Ægina," by William Watkiss Lloyd (appended to Mr. Cockerell's splendid work on these temples), London, 1860. Mr. Lloyd, in this Memoir, and in a paper "On the General Theory of Proportion in Architectural Design, and its Exemplification in Detail in the Parthenon," in "Papers read at the Royal Institute of British Architects," London, 1859, has made a valuable contribution to the establishment of some of the leading principles of the science of Greek architecture. Among the most important materials for the study as yet provided, are those to be found in Penrose's admirable work on the Parthenon, published by the Dilettanti Society, and in the volume by Mr. Cockerell, of which Mr. Lloyd's Memoir forms a part.

† Lloyd's Memoir, p. 64.

affords the standard, or ideal type. The precision with which the Greek workman — unsurpassed in manual skill, unequalled in the discipline of eye and hand — could reproduce an ideal type, is marvellous in comparison with the work of any other race. But the architect was artist as well as man of science. Numbers were to him what they are to the musician. The harmonies of his art might all be resolved into numerical relations; but these relations, within certain fixed limits, admitted of infinite variety of modulations. There is no dead repetition in a Greek building: each similar member is alike, each is different from the rest. Science gave the law; but within the law there was liberty for the free play of art. A further difficulty in determining the precise typical standard arises from the fact, that, while the refinements of the Greek architecture were almost as far beyond modern perception as they are beyond modern imitation, it is only in the most perfect buildings (such as the Parthenon and the Propylæa) that the execution can be relied upon as answering absolutely to the design. In buildings of a coarser material, — erected under supervision less careful than that of Phidias, and by workmen less disciplined than the Athenian, — the execution often falls short of absolute conformity with what seems to have been the intention; though the defect is generally so slight that it would not be noticeable in other than Greek work.

The measures of the Temple of Zeus at Olympia given by the French and the German expeditions, though not sufficient to enable us to reconstruct every part of the building, are sufficient to enable us to determine something of the system of proportions adopted in its construction; and the study of them leads to some curious results.

The main dimensions as given by the respective expeditions are as follows: * —

* For the purposes of the investigation, it is necessary to reduce the measures to Olympian or Greek feet. There is still some uncertainty in regard to the precise length of the Greek foot. In the present paper, I assume it, as deduced from a comparison of various ancient measures (see "Smith's Dictionary of Gr. and Rom. Antiquities," Art. *Mensura*), to be in relation to the English foot : : 1 : 1.01125; and hence, 1 metre = 3.24395 Greek feet.

Mr. Lloyd, basing his opinion on the measured length of the front of the Parthenon, makes the ratio of the Greek to the English foot as 1 : 1.01341; and hence, 1 metre = 3.23748 Gr. feet.

M. Aurès in his ingenious "Étude des Dimensions du Grand Temple de Pæstum," Paris, 1868, p. 4, supposes the foot used in the construction of the Parthenon to have measured M. 0.307 : hence, 1 M. = 3.25407 Gr. ft. Don Vasquez Queipo, in his "Essai sur les Systèmes métriques et monétaires des anciens Peuples," Paris, 1859, T. i. p. 387, estimates the Greek foot as being about M. 0.30864,

LENGTH ON SURFACE OF STYLOBATE.

French, M. 63.720 × 3.24395 = Gr. ft. 206.70448
German, M. 63.45 × „ = „ 205.82863

BREADTH.

French, M. 27.75 × 3.24395 = Gr. ft. 90.0196
German, M. 27.56 × „ = „ 89.40

The discrepancy shows the difficulty of obtaining exact measurements of the ruins of so large a building, originally constructed of a coarse stone, and so long exposed to the injury of time. Probably, also, the measures were not taken at the same points.

On the French plan, the diameter of a peristyle column is given at 2.244 M.; on the German, at 2.24 M.

2.244 M. = 7.27942 ft.

The French plan alone affords the measure of an upper diameter, 1.696 M. = 5.5017 ft.

Now, as we have no means, by the comparison of a number of measures of different columns, to deduce the ideal diameter, we are obliged to depend on the probable ratio subsisting between the lower and upper diameters. On inspection, it appears that the nearest likely proportion is as three to four. This proportion exists between the

or 0.308597. Herr Adler ("Ausgrabungen zu Olympia," p. 23) assumes without argument that the Olympian foot was equal to M. 0.3168. This is a wide divergence from the other authorities. The following table shows some of the various estimates: —

Lloyd . . .	1 Gr. ft. = M. 0.3089;	1 M. = Gr. ft. 3.23748
Blouet . . .	1 „ = M. 0.3068;	1 M. = „ 3.25945
Adler . . .	1 „ = M. 0.3168;	1 M. = „ 3.15656
Aurès . . .	1 „ = M. 0.307;	1 M. = „ 3.25407
Vasquez Queipo	1 „ = M. 0.3086;	1 M. = „ 3.24044
Boeckh (deduced from his estimate of the Roman foot, "Public Economy of Athens," trans. by Lamb, p. 127.)	1 Gr. ft. = M. 0.308211;	1 M. = „ 3.24453
In this paper .	1 „ = M. 0.308266;	1 M. = „ 3.24395

diameters of the columns of the Temple at Ægina.* Assuming that this is the true proportion, we correct both diameters, as follows: —

$$5.5125 : 7.35 :: 3 : 4.$$

The difference between this hypothetical lower diameter and the measured is something less than 1-104th part of the whole diameter; a difference that, even if we exclude the probability of an original deviation from the standard, may be naturally accounted for by the weathering of 2,300 years.

The French plates further give a measure of the breadth of the abacus, 2.610 M. = 8.4667 ft. This, too, should bear a definite proportion to the diameters; and we find the following ratio: —

$$5.5125 : 7.35 : 8.575 :: 4.5 : 6 : 7.$$

The difference between the measured and the computed abacus is considerable, amounting to 11-10ths of an inch, or about 1-84th of the breadth: but it is to be repeated that a single measure is never to be relied upon as giving a standard dimension; while the abacus, thrown down from the capital, has been peculiarly exposed to injury; and its edges may well have been considerably worn.

Dividing the lower diameter by 60, we have the minute or modulus of .1225; of such minutes, the upper diameter contains 45, and the abacus 70.

Having obtained the diameters of the column, we proceed to use them as data for its height. The relation between them is, as has been seen, as 3 : 4, and corresponds with the proportions of the columns of the Temple at Ægina. The height of the latter columns, as measured, is closely equal to five and one quarter times the lower diameter, or to seven times the upper diameter.† Supposing the same proportion to exist here, we have for the height of the column

$$7.35 \times 5.25 = 38.5875.$$

* In Plate vii. of Cockerell's work, the diameters of a column of the Æginetan Temple are given as respectively, 3 ft. 3 in. and 2 ft. 5¼ in.; or decimally as 3.25 and 2.438: —

$$2.4375 : 3.25 :: 3 : 4.$$

† The height of the Æginetan column (Cockerell, p. 17) is given at 17.19 ft.

Lower diameter	3.25×5.25	$= 17.0625$
Upper „	2.4375×7	$= 17.0625$

Stated in minutes, the height of the column is $60' \times 5.25 = 315'$; and it will be noticed that this is exactly three times the sum of the upper and lower diameters, $45' + 60' = 105' \times 3 = 315.'$

Having thus obtained a probable height for the column, we have, if possible, to determine that of the whole building. Mr. Lloyd has pointed out the fact, that, in the best architectural works of Greece proper, it was the rule that the height of the column should exceed one-half the height of the building, and that the excess should be equal to one part on a scale by which the whole height of the building was divided into a small uneven number of parts.*

Thus, in the Theseium, the height of the column is 5-9ths of the total height; at Bassæ, the proportion is as 7 : 13; in the Parthenon, as 10 : 19.

Upon trial, it appears that, assuming the height of the columns to be 3-5ths of the height of the building, we obtain a height for the Temple which corresponds proportionately with its measured length and breadth.†

The following table shows the proportions, using the sum of the diameters as a common measure: —

12.8625	× 3 =	38.5875	height of column.
„	× 5 =	64.3125	height of Temple.
„	× 7 =	90.0375	breadth of Temple.‡
„	× 16 =	205.80	length of Temple.

These hypothetical dimensions of breadth and length correspond, as closely as can be required, with the measured dimensions: —

Breadth, as measured by French exp., 90.0196; hypothetical, 90.0375
„ „ „ German „ 89.40
Length „ „ French „ 206.70449
„ „ „ German „ 205.82863; hypothetical, 205.80

* "Expressed more technically, the height of the column compares with the complementary height of the front, as the larger term of a super-particular ratio, — a ratio, that is, of which the terms differ by unity." — Lloyd, Memoir, p. 66.

† This is not far from the proportion of the Theseium; $\frac{5}{9} : \frac{3}{5} : : \frac{25}{45} : \frac{27}{45}$.

‡ The breadth of the abacus is often found to be a measure of the breadth of the temple. In the Theseium, the abacus measures 1-12th of the front; in the Temple at Ægina, it is 1-11th; in the Temple at Corinth, it seems to have been 1-10th; and in the Temple at Olympia, we find it 1-10¼.

$8.575 \times 10.5 = 90.0375.$

It seems hardly open to doubt, that we have thus obtained the principal normal measures and proportions of the chief dimensions of the Temple. The result appears still more striking, if we reduce the dimensions to minutes of the diameter: —

7.35 ÷ 60′	= .1225	× 105	=	12.8625
„ „		× 315	=	38.5875
„ „		× 525	=	64.3125
„ „		× 735	=	90.0375
„ „		× 1680	=	205.80

The result is confirmed by the close approximation of the ratios to those exhibited in other hexastyle temples of the same period. The ratio of breadth to length, 1 : $2\frac{2}{7}$, is the same as that of the Theseium; while the ratio of height to breadth is very near to that of the Theseium, the Temple at Bassæ, and the western front of the Propylæa.

Theseum, Bassæ, Propylæa,	Height	:	Breadth	:: 3 : 4, or 21 : 28
Temple of Zeus	„	:	„	:: 5 : 7, or 20 : 28

The measures of length and breadth which we have established are those of the upper lines of the stylobate, or platform upon which the columns stood, and the measure of the height is taken from its surface. The height and breadth of the three steps of the stylobate were carefully proportioned to each other, and to the other dimensions of the Temple; and we have now to determine what their height and breadth were, and thus to ascertain the dimensions of the Temple at the level of the ground.

The breadth of the steps of the stylobate on each end and on each side, as given by the French and German expeditions, is 1.300 M.; but, in this instance as in others, the data are not sufficient to assure us of any thing more than approximate accuracy, 1.300 M. = 4.217 ft.; and this measure, being that of the breadth of the steps on each end or side, is to be doubled to obtain the total addition to length or to breadth.

The height of the three steps of the stylobate as given by Blouet (it is not given by Adler) is apparently 1.546 M. = 5.015 ft.

The hypothetical dimensions for the total breadth of the steps seem to have been 8.575 feet, to be compared with measured 8.434; and, for the height, 5.145, to be compared with measured 5.015.

If now we add these amounts to the height, breadth, and length of the Temple, on the level of the surface of the stylobate, we have the following dimensions and relations to the common measure: —

H.	64.3125	+ 5.145 =	69.4575 =	128625 ×	5.40
B.	90.0375	+ 8.575 =	98.6125 =	„ ×	7.666
L.	205.80	+ 8.575 =	214.375 =	„ ×	16.666

The following proportions appear: —

H. from top of styl.	:	H. from base of styl.	::	25	:	28.			
B. at	„	: B. at	„	::	21	:	23.		
L.	„	„	: L.	„	„	::	24	:	25.

The height of the steps on any one side is in the ratio to their breadth of 6 : 5; and it is to the lower diameter of the column in the ratio of 7 : 10; in both these respects corresponding with other examples.*

We have now to ascertain, if possible, the height of the entablature and of the pediment, and their proportions to the other members of the front.

The total height of the Temple from the surface of the stylobate being	64.3125
And the height of the column being	38.5875
We have	25.725

to distribute between the entablature and the pediment.

The only measure of these portions of the building is that of a single block of the architrave given by Blouet (Plate 62), the height of which as measured is 5.4174.

Now, it is found that the height of the total entablature (architrave, frieze, and cornice) is not infrequently in the proportion of one-third of the height of the column, and that the architrave and frieze are of

* See Lloyd's Memoir, p. 72. In the Temple of Apollo at Bassæ, the proportion of the height of the stylobate to the diameter of the column is as 20 : 30; which may be compared with the 21 : 30 of the Temple of Zeus at Olympia. The proportion of height of steps to their breadth in the Temple of Apollo is as 6 : 5 or 42 : 35; to compare with 42 : 36 of the Temple of Zeus.

equal or very nearly equal heights, and that the cornice is usually less than one-fifth of the whole height of the entablature.

In the present case, having no measure of the frieze, we may assume that it was equal in height to the architrave; and we shall find the proportion of the entablature to the column of one-third satisfied, if we assign to the architrave the height of 5.359375, in place of the measured 5.4174.

We have then architrave	5.359375
Frieze	5.359375
Leaving for the cornice	2.14375
To make up the height of the whole entablature	12.8625

or one-third the height of the column. This division of the space — giving 5-12ths to the architrave, 5-12ths to the frieze, and 2-12ths to the cornice — corresponds with close approximation to the divisions of other well-proportioned temples.*

If this be the correct measure of the entablature, the same height remains to be assigned to the pediment; which thus appears to have had the not inappropriate proportion of one-fifth of the whole height.†

* The entablature of the Parthenon and that of the Theseium are divided as follows: —

Architrave and frieze, each	$\frac{9}{22}$ or $\frac{108}{264}$
Cornice	$\frac{4}{22}$ $\frac{48}{264}$
While the architrave and frieze of the Temple of Zeus reduced to the same denominator equal, each	$\frac{110}{264}$
And the cornice equals	$\frac{44}{264}$

Other examples are, —

Temple at Bassæ, architrave and frieze each	$= \frac{86}{84}$
In the Temple of Zeus they equal, each	$\frac{85}{84}$
„ Temple at Ægina „ „ „	$\frac{19}{47}$
„ Temple of Zeus „ „ „	$\frac{20}{48}$

† In the Temple at Ægina, the proportion was as 1 : 4.8; in that at Bassæ, as 1 : 4.7. The slight diminution in the proportion in the Temple of Zeus may have been due to its much greater height; the total height of the Æginetan Temple being but about 35.85 ft., and that of the Phigaleian Temple about 36.033.

The total façade seems thus to have had the following vertical dimensions: —

		Pediment,	12.8625 =	105′
Cornice,	5.359375			
Frieze,	5.359375	Entablature,	12.8625 =	105′
Architrave,	2.14375			
		Column,	38.5875 =	315′
			64.3125 =	525′
		Stylobate,	5.145 =	42′
			69.4575 =	567′

The next point to determine is that of the spacing of the columns. It was in the relations of the columns to each other on the fronts or sides of his temple, that the Greek architect found scope for some of the most exquisite rhythms of his art. The distances between them were not to be precisely the same, so as to afford a recurrence of precisely the same optical effects, and to repeat a measure by which the building could be at once divided into so many separate equal parts; but each columniation was to be varied sufficiently to produce the effect upon eyes, so keen and finely disciplined as those of the Greeks, of modulation, and of freedom restrained only by the general law of proportion to which the whole building was subject. On the theoretic plan, they were doubtless laid down with mathematical exactness; in the finished work, each interval had a delicate individuality, which made it incommensurable with the rest. The column at each angle of the building received almost invariably a slightly increased diameter, as having apparently to support a heavier burden than the rest; and, for this and other reasons, the interval between it and the one next to it was less than the ordinary interval.

On the plan in the "Ausgrabungen zu Olympia," the diameter of a corner column is given at M. 2.30, or 7.461 ft. Comparing this measure with the diameter of the average columns, 7.35 ft., the ideal diameter of the angle column appears to have been 7.4725; that is, its diameter at the base was increased by .1225, or one minute of the normal column.

Proceeding now to obtain the sum of the diameters on the front, we have —

4 columns, each 7.35	= 29.40
2 „ „ 7.4725	= 14.945
	44.345
Leaving for the five inter-columnar spaces . .	45.6925
Breadth	90.0375

If the front be divided into five columniations, each extending from the centre of one column to the centre of the next, we have five segments and one diameter to compose the total breadth.

Now, M. Blouet has given measures of four of the columniations on the eastern front of the Temple; so that, by adding to his measures a single diameter, and subtracting the sum from the total breadth, the remainder is the measure of the fifth segment.

The two corner columniations appear to measure, according to Blouet, respectively, 16.09 and 16.0575.* The two central columniations measured by him average 16.8961†

The sum of these four columniations is	65.9397
And if we add to this the diameter not included in the five segments	7.35
We have left for the fifth columniation	16.7478
	90.0375

The average of the two corner columniations, as measured, is 16.07375; and the average of the three central columniations is 16.84666.

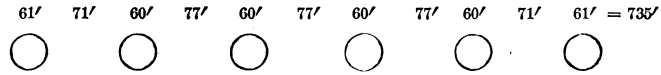
It seems not improbable that the calculated average of the

2 corner columniations was 16.17	= 132′
3 central „ „ 16.7825	= 137′

* A doubt is occasioned by the fact, that, on the plate in the Expédition scientifique, one of the central columniations is given at M. 4.960, and that this measure differs so widely and abnormally from that of the other central, and agrees so closely with that of the other corner columniation; that I am led to suppose it to be the measure of a corner columniation transferred by oversight to a wrong place on the plan.

† Blouet gives only their joint measure.

According to this, the division of the front would have been as follows: —



Feet, 7.4725 8.6975 7.35 9.4325 7.35 9.4325 7.35 9.4325 7.35 8.6975 7.4725 = 90.0375*

In respect to the internal arrangements of the Temple, such measurements as are given by Blouet, and on the German plan, though insufficient for a complete reconstruction, confirm, so far as they go, the conclusions as to the system of proportions adopted in the plan of the Temple which has now been found to exist in its external dimensions.

The breadth of the cella (including under that term the pronaos, the naos, and the opisthodomos) was, —

According to Blouet, M. 15.88 = 51.5139 feet.
„ „ German plan, 15.86 = 51.45 „

The length of the cella is not given by the Germans, nor in terms by Blouet; but as he gives the measure of the distance from the centre of one of the columns of the pronaos, and also from one of those of the opisthodomos to the edge of the stylobate, it is easy, by subtracting these measures from the measured length of the stylobate, to ascertain that of the cella.

The measure thus obtained † is 147.95 ft.; and the mathematically correct measure appears to have been 147.91875.

The proportion of breadth to length, which, for the whole Temple, is as 1 : $2\frac{2}{7}$, is for the cella as 1 : $2\frac{7}{8}$.

Cella, B. 51.45 : L. 147.91875 : : 1 : 2.875.

* This hypothetical arrangement, though it corresponds very closely to the measured dimensions, is unsatisfactory, in so far as it fails to afford in its main horizontal division any measure equivalent to the height of the column; which, as Mr. Lloyd has pointed out (Memoir, p. 70), was a symmetry frequently at least aimed at by the architect. In the Theseium, the line from the centre of an ordinary column to the further margin of a third was equal to the height of the column. In the Parthenon, three diameters and their two intercolumniations gave the measure. It may be hoped that the German expedition, before the termination of its investigations, will obtain such measurements as may determine, with certainty, the original spacing of the columns on both the fronts and sides of the Temple, and thus afford the means of ascertaining the precise ratios between the solids and the void spaces.

† I subtract from the corrected length of the Temple, — not from that given by Blouet, which (we have seen) is incorrect.

And the length of the cella is to the length of the Temple as 2.875 : 4; while its breadth is to the breadth of the Temple as 4 : 7.

The front of the pronaos and that of the opisthodomos consisted each of two columns between antæ. The diameter of one of these columns is given by Blouet at M. 1.896 = 6.1505 ft., and by Adler as M. 1.89 = 6.131 ft.

The breadth of each of the antæ of the opisthodomos is given by Blouet as M. 1.78 = 5.774 ft.
The space between antæ and column = 8.7714 „
The space between the two columns is, in the pronaos . . . M. 3.128 = 10.1470756 } Av'ge 10.0932692 „
in the opisthodomos, M. 3.064 = 9.9394628 }

Supposing these measures to be correct, the following hypothetical dimensions suggest themselves; but there is no certainty attainable with the existing data.

	Measured.	Hypothetical.		
Breadth of anta,	5.774	5.788125 × 2 = 11.57625 ft.	=	94′.5
Space from anta to column . .	8.7714	8.789375 × 2 = 17.57875 „	=	143′.5
Diam. of column,	6.13	6.125 × 2 = 12.25 „	=	100′.
Intercolumn . .	10.0932692	10.045 = 10.045 „	=	82′.
Total breadth		51.45 „	=	420′.

The breadth between the antæ is 39.87375 ft., which is to the total breadth of the cella as 31 : 40.

The depth of the opisthodomos as measured by Blouet is M. 7.22 = 23.42 ft., — very nearly in the proportion to its breadth, within the walls, of 7 to 12.

23.26 : 39.87 :: 7 : 12.

I have now gone through the principal measurements afforded by the French and German authorities. A few others of less importance will appear in the following tables, which exhibit in a condensed form the results that have been thus far obtained in this investigation, and which present (as it seems to me) an irresistible body of evidence as to the scale adopted for determining the dimensions of the Temple, and as to its principal proportions.*

* Where two measures are given for the same dimension, the first is the French; the second, the German.

Table of Exterior Dimensions.

	Measured.			Hypothetical.*
Length, on upper step of stylobate,	M. 63.720	= Gr. ft.	206.78449.	
„ „ „	M. 63.45	= „	205.83	205.80
Breadth, „ „	M. 27.75	= „	90.0196	90.0375
„ „ „	M. 27.56	= „	89.40.	
Height, from „ „				64.3125
Breadth of stylobate	M. 2.60	= „	8.434	8.575
Height of stylobate	M. 1.546	= „	5.015	5.145
Length at base of stylobate . .	M. 66.05	= „	214.264	214.375
Breadth „ „ . .	M. 30.35	= „	98.4536	98.6125
Height from „ „ . .				69.4575
Lower Diameter of peristyle column	M. 2.244	= „	7.27945	7.35
„ „ „ . .	M. 2.24	= „	7.26645	
Diameter at top of shaft . . .	M. 1.696	= „	5.5017	5.5125
Abacus, breadth of	M. 2.610	= „	8.4667	8.575
Column, height of				38.5875
Architrave, height of	M. 1.670	= „	5.41739	5.359375
Columniations, average of two central	M. 5.2085	= „	16.8961	16.84375
Columniations, average of two corner	M. 4.952	= „	16.07375	16.078125

Table of Interior Dimensions.

	Measured.			Hypothetical.	
Length of cella, including pronaos, naos, and opisthodomos		Gr. ft.	147.95	147.91875	= 1207.′50
Breadth of cella, including walls	M. 15.88	= „	51.5139		
Do. do.	M. 15.86	= „	51.45	51.45	= 420.′
Breadth between antæ .	M. 12.32	= „	39.9654	39.87375	= 325.′50
Diam. of pronaos column	M. 1.896	= „	6.15	6.125	= 50.′
„ „ „	M. 1.890	= „	6.13		

* The apparent impossibility of conforming the structure to measures so refined as these disappears, if we suppose the masons of the edifice furnished with a rule graduated with minutes of the diameter. Each minute was a little less than one-eighth of a foot. Thus, a measure that looks too delicate for execution — for example, 90.0375 ft. — was simply 735 minutes, and easily to be determined by a rule graduated with ten or five minutes.

Table of Interior Dimensions. — *Continued.*

	Measured.			Hypothetical.
Breadth of antæ in opisthodomos	M. 1.780	= Gr. ft. 5.774	5.788	= 47./25
Space from antæ to column in opisthodomos	M. 2.700	= „ 8.7714	8.789375	= 76./25
Space between columns in pronaos	M. 3.128 10.147	} Aver. 10.09	10.045	= 82./
Do. do. in opisthodomos,	M. 3.064 9.939	}		
Depth of opisthodomos .	M. 7.22	= Gr. ft. 23.42	23.2597	= 189./875
Diameter of naos column,	M. 1.54	= „ 4.99568	4.90	= 40./
			or 5.145	= 42./
Distance from front of pronaos to edge of stylobate		28.70	28.7875	= 235./
Distance from front of opisthodomos to edge of stylobate		29.15	29.09325	= 237./5
Passage between peristyle and front of pronaos		21.35	21.4375	= 175./
„ „ „ opisthodomos		21.80	21.74325	= 177./5
Passage on flank between peristyle and wall of pronaos		11.6364	11.82125	= 96./5

Tables of Proportions.

The following tables show the ratio of measures of various parts to the height, breadth, and length of the Temple: —

H = height. B = breadth. L = length.

Sum of diams.	= 12.8625 ft.	= 105′ × 3	= 38.5875,	H. of col.
„	= „	= „ × 5	= 64.3125	H. of Temple from upper surface of stylobate.
„	= „	= „ × 7	= 90.0375	B. of Temple on upper surface of stylobate.
„	= „	= „ × 16	= 205.80	L. of Temple on upper surface of stylobate.
„	= „	= „ × 5.4	= 69.4575	H. of Temple from base of stylobate.
„	= „	= „ × 7.666	= 98.6125	B. of Temple at base of stylobate.
„	= „	= „ × 16.666	= 214.375	L. of Temple at base of stylobate.

Abacus . .	= 8.575 ft.	= 70./ × 7.50	= H.	From or along surface of Stylobate.
„	= „	= „ × 10.50	= B.	
„	= „	= „ × 24.	= L.	
„	= „	= „ × 8.10	= H.	From or along base of Stylobate.
„	= „	= „ × 11.5	= B.	
„	= „	= „ × 25.	= L.	

B. of Anta	= 5.788125 ft.	= 47′.25	× 11.111	= H.	From or along surface of Stylobate.	
„	= „	= „	× 15.55	= B.		
„	= „	= „	× 35.55	= L.		
„	= „	= „	× 12.	= H.	From or along base of Stylobate.	
„	= „	= „	× 17.	= B.		
„	= „	= „	× 37.	= L.		

Architrave .	= 5.359375 ft.	= 43′.75	× 12.	= H.	From or along surface of Stylobate
„	= „	= „	× 16.80	= B.	
„	= „	= „	× 38.40	= L.	
„	= „	= „	× 12.96	= H.	From or along base of Stylobate.
„	= „	= „	× 18.40	= B.	
„	= „	= „	× 40.	= L.	

H. of Stylobate	= 5.145 ft.	= 42′.	× 12.50	= H.	From or along surface of Stylobate.
„	= „	= „	× 17.50	= B.	
„	= „	= „	× 40.	= L.	
„	= „	= „	× 13.50	= H.	From or along base of Stylobate.
„	= „	= „	× 19.166	= B.	
„	= „	= „	× 41.666	= L.	

Proportions of Cella.

B. 51.45 : L. 147.91875 : : 1 : 2.875.

L : L. of Temple : : 2.875 : 4.

B : B. of „ : : 4 : 7.

B. 420′ : B. of T. 735′ : L. of Cella, 1207′.50 : L. of T. 1680′.

: : 1 : 1.75 : 2.875 : 4.

The following table exhibits the number of minutes of the lower diameter of the peristyle column, and that of the minutes of the sum of the diameters, and that of one-hundredths of the sum of the diameters contained in the principal dimensions: —

.1225 = 1′ of D.

.128625 = 1-100 of sum of diameters.

.214375 = 1′ of „ „

			.1225 : .128625 : .214375 : : 100 : 105 : 175.		
			×	×	×
H. of col. . .	38.5875	= 315	300	180.	
H. „ . . .	64.3125	= 525	500	300.	
B. „ . . .	90.0375	= 735	700	420.	
L. „ . . .	205.80	= 1680	1600	960.	
H. from base .	69.4575	= 567	540	324.	
B. at base . .	98.6125	= 805	766	460.	
L. „ . . .	214.375	= 1750	1666	1000.	
L. of cella . .	147.91875	= 1207.50	1150	690.	
B. „ . . .	51.45	= 420	400	240.	

The preceding study of the dimensions and proportions of the Temple had been completed, and the preceding tables drawn up in the form in which they are here presented, when, on a further inspection of them, certain facts appeared, opening the way to unexpected results, which I shall now proceed to set forth briefly.

It will have been noticed that the breadth of the Temple consists of 735 minutes of the diameter of the peristyle column: —

$$.1225 \times 735 = 90.0375;$$

and it will be remembered that 7.35 is the measure of the diameter itself. The correspondence is striking; and the probability of its being an undesigned coincidence is diminished, when we further consider that in the ratio between the breadth of the Temple and the height of the column and the height of the Temple, 7 : 3 : 5, the same numbers are repeated.

Now, the lower diameter of the column is the most important dimension of the edifice. It regulates all the others, and its minute supplies the unit of the structure. The choice of 7.35 for its measure, and of 735 for the number of the minutes of which the breadth of the Temple was composed, and of 7, 3, and 5 for the ratio of breadth to heights, seems to indicate that the architect must have had a special motive leading him to select this series of digits to give the law to the proportions of his building.

It is obvious, at first glance, that 735 is composed of the first three *odd* numbers; and that peculiar virtues were supposed by the ancients to be inherent in odd numbers, is a fact familiar to all students. "Numero deus inpare gaudet," from Virgil's Eighth Eclogue (*v.* 76), is a phrase as well known to classical readers as "There 's luck in odd numbers, says Rory O'More," is to another class.

According to Servius, in his comment on this verse, this superstition was "that odd numbers were immortal, because they cannot be divided into two equal parts; the even being mortal." But this is an imperfect explanation of the matter. The superior virtue ascribed to odd numbers lay not merely in their indivisibility, — a quality which was an attribute of the divine nature, but also in the fact that they seemed stronger than the even; for in joining odd and even together, the sum was always odd. Hence, a masculine nature was ascribed to them.*

Three had dignity as the first of the odd numbers, — the first number complete with beginning, middle, and end. By it the triangle, the simplest of planes, was formed; in it were included all bodies under their three dimensions. Five was honored as the first compound of odd and even, and was regarded as thus including the virtues of both in itself. But seven was specially sacred: its properties were so numerous and so remarkable that even Cicero, in the person of Scipio, could say "rerum omnium fere nodus est." †

It might, at first sight, seem that all this subject of the mystical properties of numbers might well be relegated to the domain of merely curious learning. But the ancient doctrine of numbers, as taught by

* See Plutarch, "Of EI at Apollo's Temple," § 8, Goodwin's edition of "Plutarch's Morals," IV. 485. Also, "Roman Questions," § 25; Id. II. 218. "Cur impares numeros ad omnia vehementiores credimus?" asks Pliny, N. H. xxviii. 5. "Impar numerus mas, par femina vocatur." Macrobius, "Somn. Scip." I. vi. "Numerus impar maribus attributus est." Mart. Capella, "De Nuptiis," &c., II. § 106. "Imparem numerum antiqui prosperiorem hominibus esse crediderunt," Festus, cited by Hardouin in his note on the passage of Pliny quoted above.

† "De Republica," VII. 11. The comment of Macrobius on this passage, "Somn. Scip." I. 6, is full of illustration of the ancient ideas concerning this and other numbers. Of five, he says, "Hic ergo numerus simul omnia et supera et subjecta designat; aut enim deus summus est, aut mens ex eo nata in qua species rerum continentur, aut mundi anima quæ animarum omnium fons est." See, also, Aulus Gellius, "Noct Attic." III. 10. Morhof, in his once-noted "Polyhistor," says, "Quantæ, quam arcanæ numerorum potestates sint, ne in hunc quidem diem satis cognitum est;" and, going on to speak of the special numbers, he says, "Quinarius τροφὸς, item γάμος dicitur, quod ex binario et ternario, quasi ex femina et mare, conflatus est. Divinus aliis dicitur . . . Septenarium omnium μυστικώτατον esse nemo nescit." I. i. xii. 19. In regard to five and seven, see Plutarch, "Of EI," §§ 6–17. "Every number will afford you," says Plutarch, "sufficient matter and argument of praise, if you will but take the pains to look into it; for, to say nothing of others, a whole day would not be enough to express in words all the virtues and properties of the sacred number Seven dedicated to Apollo," § 17.

Pythagoras and his disciples, had more than a merely speculative interest: it had a substantial foundation, and a practical application. For, while in the early progress of the arts numerical relations gave to them their primal and universal laws, the mystical conceptions in respect to the absolute and inherent qualities of numbers themselves quickened the fancy of the artist, and gave him confidence in the performance of his work. "Number and figure were the greatest instruments of thought which were possessed by the Greek philosopher; having the same power over the mind which was exerted by abstract ideas, they were also capable of practical application. . . . They were the measure of all things, and seemed to give law to all things; nature was rescued from chaos and confusion by their power; the notes of music, the motions of the stars, the forms of atoms, the recurrence and evolutions of days, months, years, the military divisions of an army, the civil division of a state, — seemed to afford a present witness of them: what would have become of man, or of the world, if deprived of number?"*

It was not strange that the Pythagoreans, having recognized that the material laws of the universe could be expressed by numbers, should have mistaken this condition for the essence of the thing itself. Such a mistake is frequent in the history of thought; and it may serve to illustrate how superstitious fancies become often mingled with the most solid truths.

But to return to the number which is the special subject of this inquiry, 735, we may observe, that it not only presents in its digits the first three *numeri inpares*, but is itself composed of them, as follows: —

$$7 \times 3 \times 5 \quad \times 7 = 735;$$

and this analysis suggests another and (as I propose to show) highly characteristic and interesting set of factors; namely, —

$$35 \times 21 = 735.$$

In the well-known obscure and much discussed passage in the "Timaeus," in which the Pythagorean Timaeus gives account of the process of making of the soul, we are told that when God had mingled the three elements of which the soul is composed, and out of the three

* Jowett, Introduction to Timaeus, in "The Dialogues of Plato translated," 2d ed. III. 564. The whole passage from which the preceding extract is taken is full of striking and original reflections. Plato's own views in regard to number, and the science of arithmetic as a guide to truth, are set forth in a remarkable passage in his "Republic," book vii. 525, 526.

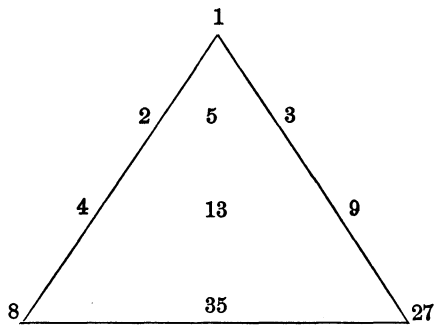
made one, he began to divide into portions the mass he had compounded, in the ratios of 1, 2, 4, 8, and 1, 3, 9, 27; and then proceeded to fill up the intervals between the terms of these ratios with fractional means, so as to form a scale of harmonic numerical proportions. The explanation and interpretation of this scale have occupied commentators both in ancient and modern times.* The exposition by Plutarch, in his treatise, "Concerning the Procreation of the Soul,

* The fullest and most satisfactory exposition of the remarkable acoustic discovery of Pythagoras in regard to the numerical relations of tones, of the nature of his musical scale, and of the notions based upon it by the ancients, is to be found in Boeckh's treatise, "Ueber die Bildung der Weltseele im Timaeos des Platon," which first appeared in 1807, and is contained in his "Gesammelte Kleine Schriften," Band 3, pp. 109–181, Leipzig, 1866. The subject is more briefly, but well treated of by Westphal, "Harmonik und Melopöie der Griechen" (Metrik der Griechischen Dramatiker und Lyriker, nebst den begleitenden musischen Künsten. Von A. Rossbach und R. Westphal, II. Theil, erste Abtheilung), Leipzig, 1863, pp. 133–139. "Die forschende Geist des Alterthums," says Westphal, "hat wohl über keine wissenschaftliche Entdeckung eine solche Freude gehabt, wie über diesen Fund auf dem Felde der Akustik. In der That macht er dem Alterthum alle Ehre. Die Töne hatten sich als verkörperte Zahlen herausgestellt, die qualitativen Unterschiede waren auf quantitative zurückgeführt. Dies führte zu dem Gedanken dass auch in den übrigen Gebieten des Kosmos in gleicher Weise die Zahl das bestimmende Princip sei. Die moderne Wissenschaft hat durch ihre grossen Entdeckungen in der Chemie und Physik (z. B. in dem chemischen Atomengesetze) die Wahrheit dieses Gedankens gerechtfertigt; aber dem Alterthume war nicht vergönnt, auf diesem Wege weiter zu dringen, man begnügte sich jenen akustischen Zahlen eine absolute Bedeutung zuzuschreiben und sie der ganzen übrigen Welt in einer rein phantastischen Weise zu Grunde zu legen. Die hohe ethische Bedeutung, welche die Musik für das Griechenthum hatte, kann diesen Irrthum entschuldigen, der sogar soweit ging, dass selbst das Seelen-und Geistesleben in jene Zahlenverhältnisse gebannt wurde. Die ganze pythagoreische und platonische Zahlenphilosophie ist auf sie gebaut. Die Zahlen 1, 2, 3, 4 enthielten die drei consonirenden Intervalle (*σύμφωνα*, nämlich 1 : 2 die Octave, 2 : 3 die Quinte, 3 : 4 die Quarte), sie zusammen bildeten den Pythagoreern die Tetraktys. Addirte man die in ihnen enthaltenen Einheiten (1 + 2 + 3 + 4) so ergab sich die Zahl 10, und so entstand der Begriff der für die Pythagoreer so bedeutsamen *δεκάς*. Rechnete man zu jenen Zahlen der consonirenden Intervalle noch die beiden Zahlen 8 und 9, welche das Ganzton-Intervall enthielten, hinzu, so ergab sich 1 + 2 + 3 + 4 + 8 + 9 = 27; die einzelnen Summanden mitsammt der Summe bildeten hier mit einander 7, und so ergab sich die *ἑπτάς*. Das sind die sogenannten heiligen Zahlen der Pythagoreer.

Von der zuletzt genannten Heptas geht Plato bei seiner Construction der Weltseele im Timaeus aus. Indem nach ihm der Weltbildner die Weltseele nach diesen Zahlen ordnet,

1, 2, 3, 4, 9, 8, 27

as discoursed in Timaeus," is of special value as a statement — in great part intelligible, in spite of the corruption of the text — of the ancient conceptions of the nature of the Pythagorean scale. He points out that this Timaean "quaternary," * as he terms it, contains two series, each commencing with the unit as their common original; next after the unit come, respectively, two and three, the first plane † numbers; then four and nine, the first squares; and, lastly, eight and twenty-seven, the first cubes. The relations of these numbers are exhibited in the following scheme: —



In this manner similar numbers, says Plutarch, are joined together, and they "will produce other remarkable numbers, as well by addition as multiplication. By addition thus: two and three make five, four

bringt er hiervon zunächst die Zahlen mit einander in Zusammenhang, welche διπλάσια διαστήματα (Octaven) und τριπλάσια διαστήματα (Duodecimen) bilden.

διπλάσια διαστ. 1 2 4 8

τριπλάσια διαστ. 1 3 9 27

* This was the second numerical Tetractys of the Pythagoreans. The Tetractys was the root or source of all things, παγὰν ἀενάου φύσεως (Carm. Aur. 48.) The first was called the Tetractys of the Ten, and was composed of 1, 2, 3, and 4, the sum of which is the perfect number 10. The second was double, 1, 2, 4, 8 and 1, 3, 9, 27. Each first number represents the point; the second, the line; the third, the plane; the fourth, the solid. The whole Tetractys is 1, 2, 3, 4, 8, 9, 27; the sum of the first six numbers being equal to the seventh. The sacred Seven includes the whole series. See Boeckh, Op. cit. p. 142.

Hierocles, in his comment on the Golden Verses says, καὶ οὐκ ἔστιν εἰπεῖν ὅ μὴ τῆς Τετρακτύος, ὡς ῥίζης καὶ ἀρχῆς, ἤρτηται. p. 230; ed. 1654.

† The ancient arithmeticians used the term *plane* numbers for those which were the products of two prime numbers.

and nine make thirteen, eight and twenty-seven make thirty-five. Of all which numbers, the Pythagoreans called five the nourisher — that is to say, the breeder or fosterer — of sound, believing a fifth to be the first of all the intervals of tones which could be sounded. But as for thirteen, they called it the remainder; despairing, as Plato himself did, of being ever able to divide a tone into equal parts. Then, five and thirty they named 'harmony,' as consisting of the two cubes eight and twenty-seven, the first that rise from an even and from an odd number; and as also being composed of the four numbers — six, eight, nine, and twelve * — comprehending both harmonical and arithmetical proportions." †

This comprehensive nature of thirty-five and the various proportional relations of its main factors, admitting of their application to every dimension in a symmetrical system, seem to have induced the architect of the Temple of Zeus to adopt it as the fundamental number for the determination of the dimensions and proportions of the building. For, upon closer investigation, it will be seen that it is not only the chief factor of the measure of the diameter of the column, but that it enters intimately into the determination of the size of every part of the building. For the minute of the diameter, which serves as the universal common measure, is one-sixtieth of 7.35, or .1225; and what is 1225 but 35×35? For example of the application of the number to the building, let us take the measure of the breadth in minutes: —

$.1225 \times 735$, that is, as we have just seen, 35 times 35 multiplied by 21 times 35. The abacus is 70′ in breadth, that is 35×2; and $35 \times 2 \times 10\frac{1}{2} = 735$, or, as above, $35 \times 21 = 735$.

If we take the length in minutes, a similar result appears: —

$.1225 \times 1680 =$ the length; that is, 35 times 35 multiplied by 48 times 35 = the length.

It is further to be noticed that 21, the factor with 35 of the breadth, is the multiple of three times 7; and that 48, the factor with 35 of the length, is composed of 35 and 13, — the latter number holding, according to Plutarch, an important place as "the remainder" in the Pythagorean scale.

* In the Pythagorean musical scale, 6 denoted the octave, 8 the fifth, 9 the fourth, and 12 unison. See Westphal, p. 133; and Boeckh, § 10, p. 146.

† Macrobius (Somn. Scip. I. vi.), commenting on the passage in "Timaeus," gives a similar scheme of the numbers. He says, "Duos esse primos omnium numerorum cubos, id est, a pari octo, ab impari viginti septem; et esse imparem marem, parem feminam superius expressimus. . . . Coëant enim numeri, mas ille qui memoratur et femina, octo scilicet et viginti septem; pariunt ex se quinque et triginta."

But this is not all: 35 being not only the measure of the minutes, but also of the number of the minutes, of which each of the principal dimensions of the building is composed, is consequently the measure of those dimensions. But here a new subtlety appears. The main dimensions are not simply multiples of 35; but they are multiples of the cube of 35 by the same factor as 35 is of the minutes by which they are measured;* for, the number of minutes which measures each principal dimension being a multiple of 35, and the minute itself being 35^2, the number of feet and decimals of a foot in the dimension equals 35^3, multiplied by the same factor as, multiplied with 35, gives the number of minutes.

Taking the breadth, for an example, again, we have seen that it is stated in

Minutes, thus	$35 \times 21 = 735'$.
Now its measure in feet is to be stated, thus . .	$35^3 \times 21 = 90.0375$
And so with the length .	$35 \times 48 = 1680'$.
„ „ .	$35^3 \times 48 = 205.8000$

It would seem that the architect, having determined to base his design upon 35, the number called harmony itself, had exercised his ingenuity in devising such dimensions for his Temple as should form a complete and most complex composition of harmonic relations.

He may in this manner have secured that satisfaction for his inventive faculty, and that freedom of independent conception, of which he was deprived, so far as concerned the general character of the building, by the prescribed scheme of the Greek Temple.

* Cube and square numbers were most highly esteemed by the Pythagoreans. They had discovered that cubes were composed of a regular sequence of odd numbers:—

The first cube, 8 of $3 + 5$.
„ second „ 27 of $7 + 9 + 11$.
„ third „ 64 of $13 + 15 + 17 + 19$, and so on.

In like manner squares, by adding the odd numbers in sequence to unity:—

The first square $4 = 1 + 3$.
„ second „ $9 = 1 + 3 + 5$.
„ third „ $16 = 1 + 3 + 5 + 7$.
„ fourth „ $25 = 1 + 3 + 5 + 7 + 9$, and so on. See Theonis Smyrnaei, Expositio eorum quæ in Arithmeticis ad Platonis Lectionem utilia sunt. Ed. Gelder, Leyden, 1827, c. xv. (p. 43); c. xxv. (p. 63).

The following table exhibits the composition of the principal dimensions: —

	Minutes.		Feet.	
Diameter at base	60′.	=	7.35	= 35 × 21.
,, at top	45′.	=	5.5125	= 35 × 14.
Sum of diameters	105′.	= 35 × 3	12.8625	= 35^3 × 3.
Height of column	315′.	= 35 × 9	38.5875	= 35^3 × 9.
,, of temple	525′.	= 35 × 15	64.3125	= 35^3 × 15.
Breadth of ,, ...	735′.	= 35 × 21	90.0375	= 35^3 × 21.
Length ,, ...	1680′.	= 35 × 48	205.8000	= 35^3 × 48.
Breadth at base of stylobate	805′.	= 35 × 23	98.6125	= 35^3 × 23.
Length ,, ,,	1750′.	= 35 × 50	214.3750	= 35^3 × 50.
Length of cella	1207′.5	= 35 × 34.5	147.91875	= 35^3 × 34.5
Breadth ,, ...	420′.	= 35 × 12	51.45	= 35^3 × 12.*

I am not aware that the application of the Pythagorean scale in any of the works of Greek architecture has heretofore been observed. It is not improbable that the architect of the Temple at Olympia may have made an exceptional use of the numbers of musical harmony. He may have been a Pythagorean by training. But it also is not unlikely (although we have no evidence as yet of the fact) that the Greek architects recognized a relation between the harmonies of music and those of their own art; and that some of them, adopting the Pythagorean doctrine of numbers as the key of Nature, and the origin of the order of the universe, believed that the most perfect works of their art were to be achieved by the conformity of their designs to the principles of the architecture of the world. The law of harmony must be one for the rolling of the spheres, and for every tone of the lyre or the lute; one for the proportions of the starry habitations, and for those of the earthly temples of the gods.

* It will be noticed that the factors of the dimensions are, except in two instances, whole multiples of 7, or 3, or 5, and that, of the two exceptions, one, 23, is composed of 3 multiplied by 7.666, and the other, 34½, of 3 multiplied by 11.5.